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THE IMPACT OF SALIENT NAMING TARGETS DURING APHASIA THERAPY

By

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Thesis

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The Impact of Salient Naming Targets during Aphasia Therapy

Chairperson: Julie Wolter, Ph.D

Translational research has led to aphasia therapies that incorporate principles of experience dependent neuroplasticity. The neuroplasticity principle of salience has received less attention from speech language pathologists than other principles, such as dose and treatment intensity. Incorporating salience in aphasia therapies has the potential to increase functional outcomes by addressing multiple aspects of the World Health Organization's International Classification of Functioning, Disability and Health. This study explored the impact of salient stimuli targets on picture naming acquisition and maintenance for two individuals with chronic aphasia, following cerebrovascular accident. Participants were enrolled in a five-week Intensive Comprehensive Aphasia Program (ICAP) at the time of the study. A single subject A-B-A research design was implemented to assess the role of saliency during naming acquisition. Photographic stimuli were created from "salient" words chosen by each participant. Control photographic stimuli matched the salient targets' syllable length and frequency. Three baseline probes assessed pre-treatment naming accuracy, three naming probes were delivered during the treatment phrase, and three post-treatment probes were delivered within one week of the last intervention. Twelve, forty-five-minute, evidence-based treatment sessions were implemented during the treatment phase of the study. Effect sizes for the salient stimuli were large for both participants: P1 (d=4.04), P2 (d=4.08). The control stimuli effect size for P1 was large (d=2.14) and medium (d=.64) for P2. This preliminary study suggests that incorporating salient targets in confrontational naming therapies increases naming acquisition and maintenance of naming targets. Implications for these findings further support the use of person specific, highly motivating, salient stimuli in anomia therapies to increase functional outcomes and quality of life.

Keywords: anomia, salient, aphasia, naming

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Table 1

Definition of Terms

Acetylcholine	Neurotransmitter used by the peripheral nervous system and central nervous system. Acetylcholine activates muscles and is a major neurotransmitter of the autonomic nervous system. In the central nervous system acetylcholine supports cognitive function.
Amygdala	One of two almond-shaped set of neurons located deep within each temporal lobe. The amygdala is an integrative center for emotions and motivation.
Anterior insula	The anterior insula is located deep within the lateral sulcus of the brain and is responsible for the conscious awareness of emotions.
Aphasia	Aphasia is an acquired language communication impairment affecting the production or comprehension of speech and the ability to read and write. Aphasia is due to brain injury, most commonly caused by stroke. Aphasia may also develop as a result of head trauma, infection or tumors. Aphasia does not affect intelligence.
Cerebrovascular	Blood vessels of the brain
Cholinergic	Pertaining to nerve cells in which acetylcholine acts as a neurotransmitter
Hebbian	Hebbian theory is a neuroscientific theory in which repeated stimulation of neural cells leads to synaptic strengthening. Hebbian theory is central to learning and neural plasticity.
Lexicon	A person's vocabulary
Likert Scale	Psychometric rating scale that is commonly used with questionnaires.
Neuroplasticity	Process of changing brain form and function in response to learning or experience following brain injury.
Neurorehabilitation	Process to aid recovery from a nervous system injury that promotes neural regeneration, repair and dynamic reorganization of functional neural systems.
Paraphasias	Production of unintended words or phrases
Salience	The quality of being particularly noticeable or important.
Substantia Nigra	A basal ganglia structure containing dopamine producing nerve cells, which play an important role in reward and movement.
Ventral Striatum	The ventral portion of the striatum, which is part of the basal ganglia. The ventral striatum plays a role in the brain's reward system.

Table 2

Abbreviations

CILT	Constraint-Induced Language Therapy
CVA	Cerebrovascular Accident
fMRI	Functional Magnetic Resonance Imaging
NHS	National Health Service- UK
NIH	National Institutes of Health
QOL	Quality of Life
SN	Salience network
UK	United Kingdom
VNeST	Verb Network Strengthening Treatment
WHO ICF	World Health Organization’s International Classification of Disability and Health

The Role of Salient Naming Targets in Aphasia Therapy

Introduction

Aphasia is an acquired communication disorder caused by damage to areas of the brain responsible for language production and comprehension. Aphasia currently affects between two to four million Americans (Simmons-Mackie, 2018). Brain damage associated with aphasia is most commonly induced by stroke but infection, traumatic brain injuries, tumors, and neurologic disease may also cause aphasia (NIH, 2017). Although spoken language production, speech comprehension, reading, and writing may all be affected by aphasia, word retrieval is a persistent, ubiquitous characteristic (Davis, 2005). Loss of lexical retrieval, or anomia, is a difficulty or an inability to verbally produce the names of items, people, places, or actions (National Aphasia Association, 2018). Many researchers agree that aphasia-associated anomia occurs as a result of complications of accessing intact language representations rather than the loss of those representations (Simmons-Mackie, 2018; Silkes, McNeil & Drton, 2004).

Traditionally, aphasia has been characterized by impairments to brain structure and function such as lesion site and type and severity of language impairment. However, the World Health Organization's International Classification of Functioning, Disability, and Health (WHO, ICF, 2001), classifies disabilities in terms of multiple dimensions including: structure and function, activities and participation, and personal and environmental context (Kagan, Simmons-Mackie, Rowland et al., 2007). The WHO ICF model provides a shift from assessing and treating aphasia in terms of structure and function to one that assesses the impact of aphasia on an individual's quality of life. Because communication is required for most daily activities, aphasia often has a devastating effect on an individual's ability to participate in their typical activities, social interactions, and life's roles (Efstratiadou, Papathanasiou, Holland, Archonti & Hilari, 2018).

Loss of employment, independence, and involvement in hobbies often leads to changes in social roles. Ross and Wertz (2003) implemented a non-randomized observational group design to compare 24 facets of quality of life (QOL) as determined by WHO (2001) for 18 individuals with and without aphasia. Facets within three domains including independence, environment, and social relationships differentiated the two populations and were found to be the best indicators of QOL. Applying the WHO ICF model to people with aphasia allows researchers and rehabilitation speech-language pathologists to assess the overall impact of aphasia to an individual's life. The WHO ICF model also provides a framework for researchers and clinicians to design meaningful therapies that increase site-specific communication and social participation, and enhance QOL (Simmons-Mackie & Kagan, 2007). Research that further investigates the use of person-specific, meaningful stimuli for use in clinical settings may enhance motivation, social participation and QOL for people with aphasia.

Aphasia Treatment and Neuroplasticity Research

Over the last decade, translational research emerging from collaboration between speech-language pathologists and neuroscientists has resulted in aphasia treatment protocols that incorporate theoretical foundations from both sciences (Raymer et al., 2008). Neuroscientists have identified ten principles of experience-dependent neuroplasticity fundamental to brain damage neurorehabilitation, which may be directly applicable to treating aphasia (Kleim &Jones, 2008). Neuroplasticity refers to the brain's ability to change structure and function in response to environmental pressure (Black et al., 1997). The ten principles of experience-dependent neural plasticity include: (1) use it or lose it, (2) use it and improve it, (3) specificity, (4) repetition matters, (5) intensity matters, (6) time matters, (7) salience matters, (8) age matters, (9) transference, and (10) interference. Aphasia researchers have incorporated the neuroplasticity principles of constraint, intensity, and repetition into behavioral treatments specifically aimed at anomia (Off & Griffin, 2015; Pulvermuller et al., 2001; Meinzer, 2007; Mozeiko et al., 2016). For example, constraint induced language therapy (CILT) is an intensive aphasia naming therapy that promotes verbal speech by emphasizing the forced use of verbal responses. Constraining the PWA to a verbal response is theorized to prevent learned nonuse and further loss of cortical and neuromuscular regions associated with speech (Pulvermuller, Neininger, Elbert, & Taub, 2001). While constraint induced therapies are efficacious for many individuals with aphasia-induced anomia (Kurland, Pulvermuller, Silva, Burke & Andrianipolus, 2012) negative patient response has been documented with the use of CILT due to the frustration of forced verbal communication (Rose, 2013). CILT, like other aphasia therapies that incorporate the use it or lose it, repetition, and intensity principles of neuroplasticity address the WHO ICF's body function and structure aspects of aphasia but they do not directly address the activity, environment, and personal factor components of the WHO ICF model. Holistic aphasia treatments that are personally motivating and address all components of the ICF model are needed.

Saliency Research

One principle of neuroplasticity that has received less attention among speech-language pathologists is the principle of "salience" (Raymer et al., 2008); yet salient aphasia therapies have the potential to incorporate the personal factors and activity aspects of the WHO ICF model. Salience, or the importance of an experience, is thought to play a role in brain damage rehabilitation (Kleim & Jones, 2008). Neurological-based language therapies involving salience rely on stimuli or activities that are important and motivating to an individual.

Researchers began investigating salience by proposing a model for a neurological system that encodes important experiences that direct behavior in response to an ever-changing environment (Galambos, Sheatz & Vernier, 1956; Weinberger & Diamond, 1987). For example, Weinberger (2004) provided evidence for such a system by using auditory tones as stimuli. Laboratory rats injected with a C14 labeled glucose were trained to associate a 6.0 KHz tone with the opportunity to press a bar for water (Rutkowski, Than & Weinberger, 2002; Weinberger 2004). Audio radiographs indicated that the rats trained to respond to the acoustic stimuli for water exhibited a glucose uptake confined to loci in the auditory cortex around 6.0 KHz. The rats were 85% accurate in their response for water. The control group showed no change in auditory complex organization. Thus, due to a reward, physiological plasticity was induced by one tone being more behaviorally important or "salient" than the other. Furthermore, previous studies indicated when a tone was paired with stimulation to the forebrain cholinergic system of laboratory rats a similar increase in representation of the tone was observed (Dimyan & Weinberger, 1999). In addition, another study found that lesions involving cholinergic neurons in the forebrain disrupted learning and auditory representations (Kudoh, Seki, & Shibuki, 2004). Human patients given an acetylcholine antagonist also demonstrated reduced activity in the auditory complex while attempting to discriminate between specific tones (Theil, Bently & Dolan, 2002). As a result of these studies, neuroscientists proposed that a neural system involving acetylcholine mediates saliency and that engaging this system contributes to experience-dependent plasticity (Connor, Chiba, & Tuszynski, 2005). Thus, further research into aphasia therapies that involve the cholinergic system and saliency would likely demonstrate neurologic plasticity in the associated language domains.

The salience network (SN) plays a crucial role in identifying biologically and cognitively relevant events that shape behavior (Besissner, Meissner, Bar & Napadow, 2013). Brain imaging studies using functional connectivity analysis of functional magnetic resonance imaging (fMRI) data have identified a large-scale network anchored to the anterior insula and dorsal anterior cingulate cortex (Menon, 2015). The anterior insula has also been implicated in the regulation of feelings into cognitive and motivational processes (Namkung, Sun-Hong & Sawa, 2017). Subcortical structures of the amygdala, ventral striatum, and substantia nigra also play a role in the salience network. The anterior insula acts as a dynamic hub linking sensory, emotional, and cognitive information to the dorsal anterior cingulate cortex to facilitate rapid access to the motor system (Menon, 2015). Thus, the salience network identifies and attends to both internal and external salient stimuli and responds in an adaptive manner (Lovero, Simmons, Aron & Paulus, 2009). The identification of a salience network further strengthens the argument for researching aphasia therapies that incorporate salience to promote plasticity driven neurorehabilitation of communication.

Salience in Aphasia Therapy

Although researchers have identified the brain regions associated with the salience network (Menon, 2017), the influence of salience on aphasia recovery is not well understood. However, preliminary studies assessing the use of personally relevant photographs for picture-word matching (Mckelvey, Hux, Dietz & Beukelman, 2010) and personally relevant words in script writing (Cherney, Kaye, Lee & vanVuuren, 2015) for people with aphasia (PWA) are promising.

Mckelvey et. al., (2010), used a single subject design to determine whether contextualized, personally relevant (salient) photographs would increase client motivation and comprehension when used for picture-word matching. Non-personally relevant, contextualized photos and simple iconic images were both used as controls. Three types of target words were used for matching with the images: (1) labels of people or objects, (2) actions, and (3) socially relevant events.

McKelvey and colleagues (2010), selected eight adults with severe aphasia who were given experimental tasks to evaluate stimuli preference and word-picture matching accuracy. Two findings emerged from the data. First, the participants indicated a preference for using personally relevant, contextualized photos to represent words, and second, participants were significantly more accurate ($p \leq .0473$) when matching personally relevant, contextualized photos to target words than to the controls. The authors concluded that clinicians would likely experience greater success during aphasia therapy by using personally relevant, contextualized photographs as stimuli for picture–word matching activities. The authors further suggested that personally relevant, contextualized "salient" photographs take advantage of residual strengths of PWA including, memory, intellect, and visual perception and provide greater incentive to complete therapy sessions that require massed practice. Although Mckelvey et al. (2010) demonstrated evidence for the use of salient photographs in picture–word therapy, future research should incorporate clients with multiple types and severity of aphasia.

Cherney, Kaye, Lee and van Vuuren (2015) analyzed the role of salience in script training used during aphasia therapy. Script training, a social approach to aphasia treatment, typically involves repeated verbal practice of phrases or sentences specific to the client's daily life. Script practice can be accomplished by reading aloud a script, producing a script from memory or a combination of these activities. The premise behind script training is based on the instance theory of automatization (Logan, 1988), which purports that automatic skills are achieved by retrieving memories of specific, context bound experiences which are repeatedly encountered. Script training generally involves practicing a particular script that may be used in daily life with the intention of producing relatively fluent automatic speech (Youman, Youmans, & Hancock, 2011). Scripts may target communicative interactions at restaurants, grocery stores or even when speaking with grandchildren. Multiple studies have demonstrated qualitative efficacy for the use of script training therapy to increase communication and participation in daily life activities for people with aphasia (Cherney, Halper, & Kaye, 2011; Yourman et al., 2010; Bilda, 2011). Building upon Mckelvey et al.'s (2010) salient word-picture matching research, Cherney et al., (2015) used a single-subject design, involving eight participants with chronic aphasia to compare acquisition and generalization of personally relevant versus generic words used in script training. For each participant, two scripts, one trained, one untrained, were created. Each script contained four personally relevant or "salient" words and four generic words. The participants practiced the trained scripts for 90 minutes a day, six days per week, for three weeks using AphasiaRX™ software. During the training sessions, a digital therapist guided the participants through the printed script. At first, the participants listened to the entire script while reading along. Next, the participants practiced their portion off the script with choral reading and finally, they performed their responses independently. Baseline accuracy probes were conducted pre and post treatment for the trained and untrained scripts. The probes were conducted using high quality audio recordings through the client's home computers using AphasiaRX™ software. The recordings were later assessed by the researchers for accuracy of production using the Naming and Oral Reading for Language in Aphasia (NORLA-6) scale (Ginrich, Herwitz, Lee, Carpenter, & Cherney, 2013).

Significant word production improvements were demonstrated by participants using the trained scripts for both the salient and generic items. Improvements in accuracy on untrained scripts were smaller but the personally relevant words did reach the level of significance. Using a paired, one tailed t test, post-treatment probes revealed a significant increase in accuracy of personally relevant ($p < .011$) and generic words ($p < .005$) in the trained script. However, a paired, one tail t test demonstrated that the gain made on personally relevant to generic items was not significant ($p = .059$) but the effect size was large (Cohen's $d = 0.9$). For the untrained scripts, participants demonstrated a significant increase in accuracy for personally relevant items ($p < .05$) and a non-significant gain for generic items ($p = .067$). The authors concluded that personally relevant or salient words were acquired more successfully than generic words through script training. Although questions concerning this study include participant compliance and therapy quality using aphasiaRX™ software, preliminary data suggests that incorporating salience in aphasia script writing therapy provides better functional outcomes.

Over the last decade our understanding of the salience network and its importance to neurorehabilitation of individuals with aphasia has greatly increased; yet, the use of salience in clinical aphasia therapies needs further analysis. Current naming therapies focusing on the treatment of anomia use the principles of constraint, intensity, and repetition (Pulvermuller et al., 2001; Meinzer, 2007; Mozeiko et al., 2016). These treatments have shown efficacy for naming but they do not specifically address the activity, environment, and personal factor components of the WHO ICF model. Because salient therapies use words, phrases, or activities specifically important and motivating to an individual, incorporating salient targets into aphasia therapy has the potential to result in higher functional outcomes and quality of life ratings. Mckelvey and colleague's (2010), picture-word therapy and Cherney et. al.'s (2015) script writing research has provided evidence for the use of salience in aphasia therapies to improve outcomes for individuals with severe aphasia. However, further research using salience in the treatment of individuals with different types and severity of aphasia is needed. Using salient targets in naming therapies is one way to assess the role of salience for individuals with less severe forms of aphasia. The current study was designed to explore the impact of salient stimuli targets on picture naming acquisition and maintenance for individuals with aphasia-associated anomia.

Method

Participants

Two individuals served as participants for this investigation, both of whom presented with chronic aphasia resulting from a left-hemisphere stroke. Both individuals were enrolled and participating in an Intensive Comprehensive Aphasia Program (ICAP) during the summer of 2018 at the University of Montana. The participants both provided informed consent and the study was approved by the University of Montana's Institutional Review board for research involving human participants (IRB # 85-18). Both participants were right handed and native speakers of American English. They each passed a pure-tone hearing screening and reported a negative history for premorbid speech and language impairments, alcohol and substance abuse, and psychological disorders. The participants did not receive speech-language therapy outside of the ICAP during the study (see Table 3 for a description of participant characteristics).

Table 3
Participant Characteristics

Characteristic	P1	P2
Age	64 years	65 years
Gender	Male	Female
MP0	48 months	31 months
CVA –location/type	LMCA/ischemic	LCA/ ischemic
Education level	Master's degree	Master's degree
Marital status	Married	Single
Race/ethnicity	Caucasian	Caucasian

Note. MPO = months post-onset of stroke, LMCA= Left middle cerebral artery, LCA= left carotid artery

The participants were each administered part 1 of the *Western Aphasia Battery*, revised (WAB-R: Kertesz, 2007) to assess for the presence or absence of aphasia as well as for the type and the severity of aphasia. The WAB-R subtests included Spontaneous Speech, Auditory Verbal Comprehension, Repetition, and Word Finding. The participants were also administered the *Boston Naming Test, second edition* (BNT-2; Kaplan, Goodglass, & Weintraub, 2001) to assess confrontational picture naming of nouns of decreasing word frequency. *The Assessment of Living with Aphasia* (ALA: Simmons-Mackie, Kagan, Victor, Carling-Rowland, Mok, Hoch, Huijbregts, & Streiner, 2013), a patient-reported outcome (PRO) measure, was administered to assess the impact of aphasia on quality of life.

Participant 1 is a 64-year-old male who presented with moderate non-fluent aphasia characterized by moderate verbal production impairments, concomitant apraxia of speech, and right-sided hemiparesis stemming from a 2014 cerebrovascular accident (CVA) of the left middle cerebral artery (MCA). Participant 1 received a Master's degree in comparative linguistics and served 24 years in the U.S. Air Force as a linguist. Prior to his stroke, he was fluent in Polish and Swedish. Participant 1's Aphasia Quotient (AQ) score of 70.1/100 from the *WAB-R* was consistent with a classification of moderate, non-fluent aphasia. Participant 1's word retrieval difficulties were evidenced by the use of circumlocution, gesturing, and one-word answers used during spontaneous speech. Participant 1's score of 40/60 (2.89 standard deviations below the mean) on the *BNT* indicated a significant impairment in lexical retrieval during confrontational naming. Participant 1's score of 3.5/4.0 on the *ALA* indicated that aphasia has had a mild impact on his quality of life across communication, environment, and personal domains. See Table 4 for a summary of participant 1's assessment scores.

Participant 2 is a 65-year-old female who suffered a left hemisphere ischemic CVA to the left carotid artery in 2015. Participant 2 demonstrated mild, fluent, anomic aphasia characterized by subordinate and uncommon semantic paraphasias. Participant 2 received her Master's degree in clinical psychology during the 1970's and worked as a drug and alcohol addiction counselor prior to her stroke. She also reported being fluent in German and Spanish prior to her stroke. Participant 2's AQ score of 89.4/100 from the *WAB-R* indicated a diagnosis of mild, fluent, anomic aphasia. Her *BNT* score of 35/60 (four standard deviations below the mean) demonstrated a significant impairment in lexical retrieval during confrontational naming. Participant 2's *ALA* score of 3.11 indicated that aphasia had significantly affected her quality of life. See Table 4 for summary of participant 2's assessment scores.

Table 4

Pretreatment Assessment Scores

Assessment	P1	P2
WAB-R Aphasia quotient	70.1/100	89.4/100
WAB-R Spontaneous speech	13/20	18/20
WAB-R Auditory verbal comprehension	9.1/10	9.2/10
WAB-R Repetition	6.2/10	9.4/10
WAB-R Naming/word finding	6.8/10	8.1/10
BNT-2 (standard form)	40/60	35/60
ALA	3.5/4	3.11/4

Note. WAB-R= *Western Aphasia Battery Revised*, BNT-2= *Boston Naming Test-2*, ALA= *Assessment of Living with Aphasia*

Experimental Stimuli

Photographic stimuli were created to use during confrontational naming therapy from a list of words specifically chosen by each participant. Both participants were asked to select 25 personally relevant and motivating words from a 100-word list questionnaire (Palmer, Hughes &

Chater, 2017) sent out and returned prior to the start of the Big Sky Intensive Comprehensive Aphasia Program (see Appendix A). The word list was created from the research results of Palmer and colleagues (2017) who conducted a study to identify words generally salient to PWA. The researchers recruited 100 participants previously selected to participate in the 2015 Big Cactus Aphasia Study conducted by the National Health Service (NHS) in the United Kingdom (UK). The Big Cactus Study, a randomized controlled experiment assessing computerized word finding therapy, involved 278 participants with stroke- induced aphasia from 20 different regions of the UK (Palmer et al., 2015). The first 100 participants of the Big Cactus Study were asked to choose 100 words that they would find useful for everyday communication. The 9999 words (one participant submitted 99 words) provided by the participants were analyzed. Terms that contained more than one word were linked together (i.e., “cup of tea” became “cupoftea”). Plural and singular forms of a word were considered the same word. Of the 9999 words provided, 3095-word types were represented. The words were further analyzed for frequency and semantic category. From the 100 most frequently chosen words, 79.4% represented eight distinct semantic categories. Thirty percent of the words were types of food and drink, 10.3% pertained to tools and gardening, 9.4% concerned entertainment, 7.3% fit the places category, 6.5% were associated with home, 5.2% pertained to clothes, and 3.5 % pertained to travel. Palmer and colleagues concluded these 100 words to be considered “salient” for researchers and therapists to use during word finding therapies.

Participant 1 and 2 were asked to choose 20 personally relevant and motivating words from Palmer et al.’s (2017) list of 100 words. The participants were further asked to categorize their words using a Likert scale as: (1) somewhat relevant and motivating, (2) relevant and motivating or, (3) highly relevant and motivating. The questionnaire also provided five spaces for personally relevant words such as "hockey" and "apartment". From the participant word list, 20 of the most highly relevant words, as determined by the Likert scale and added words, were selected by the researchers and made into 8.5 by 11-inch color photographs from publicly available pictures on the Internet. Control items were selected from a previously developed corpus of 240 digitized color photographs (Off, et al., 2015), controlling for word length and frequency between target stimuli and control stimuli.

Participant 1 selected 3 somewhat motivating words, 11 motivating words, and 6 highly motivating words. Participant 1 also added the following five personal words: *apartment, left, right, Meridian, and Avant*. The somewhat motivating words were not used and two of the personal words (*Meridian* and *Avant*) were not used due to confusion surrounding their use. The motivating, highly motivating, and remaining three personal words were compiled to create a list of 20 salient words which were paired with 20 randomly selected control words (see Table 5). Participant 2 selected 18 highly motivating words total from the questionnaire. She did not add any personal words. The 18 words selected were paired with 18 control words (see Table 5). A binder was created for each participant containing his or her "salient" and control photographic stimuli.

Table 5

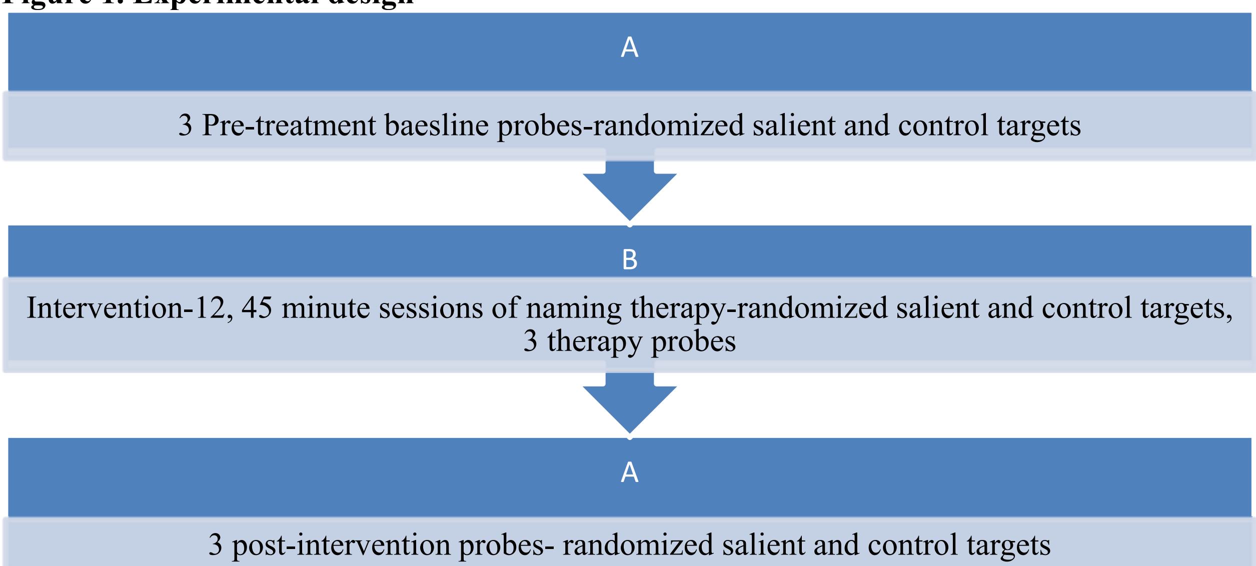
Photographic Stimuli

P1 Salient Targets	P1 Control Targets	P2 Salient Targets	P2Control Targets
Burger	Ant	Coffee	Ant
Pizza	Book	Chicken	mouse
Ice-cream	Bottle	Cookies	Slippers
Hockey	Candle	Sandwich	Farmer
Beer	Chair	Dress	Leg
Wine	Cricket	Burger	Eyes
Fork	Door	Strawberries	Candle
Steak	Drawer	Fries	Drawer
Pants	Dryer	Chocolate	Rose
Shirt	Mouse	Chinese-food	Book
Jeans	Rose	Cauliflower	Bottle
Sandwich	Plunger	Mushrooms	Hanger
Football	Leg	Breakfast	Glass
Lasagna	Harp	Cucumber	Door
Shrimp	Hanger	Sausages	Flashlight
Car	Glass	Wine	Harp
Shoes	Frog	Kitchen	Plunger
Right	Flashlight	Cherries	Dryer
Left	Farmer		
Apartment	Eyes		

Experimental Design

A single subject A-B-A research design was implemented to assess the role of saliency during naming acquisition. An A-B-A single subject design provides information about how an individual responds to an independent variable (salient targets) and the participant acts as his or her own control (Baer, Wolf & Risley, 1968). The first A of the A-B-A design represents the baseline of the dependent variable. In this study, the dependent variable was confrontational naming ability, which was determined by percent naming accuracy. The baseline demonstrates the participant's level of target behavior and predicts future ability without intervention. Three baseline probes were administered to account for individual, day-to-day naming variability that is inherent in individuals with aphasia. The B component of the A-B-A design represents the intervention or therapy using salient targets. The intervention period was four days per week for 45 minutes per day and occurred during the Big Sky Aphasia Intensive Comprehensive summer 2018 program. Three naming probes were administered during the therapy portion of the experimental design. The last A of the A-B-A design represented the final three naming probes taken after the intervention period was complete. See Figure 1 for a visual depiction of this experimental design.

Figure 1. Experimental design



Note. All probes and interventions took place over 5 consecutive weeks of the summer 2018 Big Sky Aphasia Program (BSAP), an Intensive Comprehensive Aphasia Program (ICAP) at the University of Montana.

Participant 1 and 2 both received three baseline probes to assess their ability to name both the salient pictures and the control pictures. The pictures were randomized using RANDOM.ORG prior to each probe. The baseline probes were administered over the first three consecutive days of the Big Sky Aphasia Intensive Comprehensive Program. Therapy probes were administered at the end of each week of therapy for a total of three probes. Three final post-therapy probes were administered within one week after the last intervention was completed.

Dependent Measures

Confrontational naming probes

Naming probe procedures were consistent throughout the study. Each participant was presented with a single picture from their binder of salient and control items and asked to name aloud the item. The pictures were randomized prior to each probe. The participants were given 20 seconds to respond to each target. All salient and control picture targets were used during each probe. The investigator and a trained undergraduate research assistant each orthographically recorded the participants' verbal responses. Recorder agreement was 99%. Probe sessions were also video recorded for accuracy. The naming productions were scored as correct or incorrect and assessed for error type (see Table 6 for error types and their descriptions). Naming errors were grouped into the following categories: (1) semantic paraphasias (e.g., "cat" for "dog"), (2) phonological paraphasias ("tum" for "thumb"), (3) neologisms (e.g., "clug" for "grass"), and (4) performance errors (e.g., slurred speech). Semantic paraphasias were further categorized using the Snodgrass and Vanderwalt (1980) and Corina et. al., (2010) classification schema into one of six categories: (1) coordinate-a different exemplar from the same category, (2) associate- a related response that does not share semantic features, (3) superordinate- a more general response, (4) subordinate- a more specific response, (5) part to whole or whole to part, and (6) circumlocution. During each probe session the examiner gave the instructions, "I'm going to show you some pictures. Please tell me the name of the item in each picture. I will not be giving you any feedback." The correct responses were calculated for both the salient and control words after each probe.

Table 6

Error Types

Error category	Definition	Example
Phonological paraphasias	Phonemic change	
• Epenthesis	Insertion of a phoneme	pants-plants
• Omission	Deletion of a segment	spoon-poon
• Substitution	Phonological substitution	rat-bat
• Metathesis	Exchange of segments	ask-acts
• Repetition	Repetition of word or segment	bat-babat
Semantic paraphasias	(semantically similar word)	
• Coordinate	Difference exemplar from Same category	fork-spoon
• Associate	Related but doesn't share semantic features	backpack-boots
• Superordinate	More general	cake-dessert
• Subordinate	More specific	car-Ford
• Part to whole		hand-finger
• Whole to part		finger-hand
Circumlocution	Talks around target	hat-on head, warm
Neologisms	Nonexistent words	cat-tands
Performance	Form distortions	chair- chair (distorted)
Other	Does not fit given categories	table-mice

Note. Error types from Corina, Loudermilk, Detwiler, Martin, Brinkly & Ojemann (2010); Snodgrass & Vanderwart (1980)

Treatment

Forty-five-minute treatment sessions were provided three times per week, over four weeks, by graduate student clinicians under the supervision of a certified speech-language pathologist (SLP). Treatment sessions targeted lexical retrieval of the participant's salient and control words. Each therapy session was conducted in a quiet, private therapy room. Evidence based therapies were chosen for each participant with regard to aphasia type (i.e., fluent/non-fluent), client goals, and supervising SLP expertise.

Therapy sessions for participant 1 included Semantic Features Analysis (SFA; Boyle & Coelho, 1995)) and sentence expansion through Verb Network Strengthening Treatment (VNeST; Maddy, Capilouto, & McComas, 2014). Participant 2 received SFA therapy for all therapy sessions. SFA involves the use of a semantic chart containing the following semantic features: (1) group, (2) association, (3) properties, (4) location, (5) use, and (6) action to improve semantic activation and increase naming accuracy. SFA is an evidence-based treatment approach designed to enhance the activation of a target word by the processing of shared features. SFA provides individuals with aphasia an activation route by which they can access lexical items from their mental lexicon (Boyle, 2010). VNeST is a treatment approach used to strengthen lexical retrieval in sentence contexts with the potential for the generalization of more lexical access (Edmonds, Nadeau, & Kiran, 2009). VNeST is based on the premise that semantic verb networks are created from neural networks strengthened through Hebbian learning, which is the increased synaptic efficacy that develops from repeated stimulation. There is also evidence for bidirectional co-activation between verbs, associated nouns, and priming from their locations (Park & Edmonds, 2013). During VNeST therapy, Participant 1 was given a verb associated with one of the provided pictures and asked to generate a Subject-Verb-Object (SVO) sentence.

Data Collection and Analysis

Participant naming accuracy results for all baseline, treatment, and post-treatment probes were entered into Excel for statistical analysis. Means and standard deviations were calculated for baseline, treatment and post treatment probes for both salient and control items. The magnitude of change, or effect size, for both the control and salient data from baseline to post treatment was calculated using a variation of Cohen's (1988) *d* statistic as calculated by Busk and Sterlin (1992). Visual inspection graphs were created to compare control and salient data.

Results

Picture Naming Accuracy

Picture naming accuracy was collected for salient and control targets for both participants (see Table 7). Visual analysis of pre-treatment, treatment, and post-treatment naming accuracy probes demonstrate increased naming accuracy for both salient and control stimuli for both participants (see Figures 2 and 3 for participant 1 and participant 2, respectively).

Table 7

Percent Naming Accuracy for Naming Probes

		BP1	BP2	BP3	TP1	TP2	TP3	PTP1	PTP2	PTP3
P1	**Salient**	75%	80%	80%	75%	85%	90%	85%	95%	90%
	Control	35%	60%	55%	50%	65%	85%	70%	75%	90%
P2	**Salient**	78%	83%	78%	89%	78%	83%	83%	100%	94%
	Control	72%	78%	94%	83%	83%	89%	89%	89%	89%

Note: All probe results for P1 are % correct/20 and for P2 % correct/18; BP = baseline probe; TP = treatment probe; PTP = post treatment probe

Participant 1. As seen in Figure 2, treatment was associated with improved naming accuracy for both the control and salient targets. Participant 1 produced four salient target words that were considered unstable during the pre-treatment probe. Unstable was defined as producing a naming error during at least two out of three pre-treatment probes. Seventy-four percent of those salient targets were considered stable during the post-treatment probes. Stable was defined as producing an accurate naming target in two out of three post-treatment probes. Participant 1 produced ten control target words that were unstable during the pre-treatment probe and 60% of those targets became stable after treatment. All of the words that had been selected as highly motivating were stable during the baseline probes and remained stable during the post-treatment probes. Two of the three personal words chosen by participant 1 were also stable during the baseline probes and remained stable during the post-treatment probes. The one personal word which was not considered stable during the baseline probe became stable during the post-treatment probes.

Participant 1's impairment-based, linguistic outcome measure test scores (i.e., WAB-R and BNT) increased following the ICAP treatment (see Table 8). Although these improved outcome measures cannot be specifically attributed to the use of salient targets, the cumulative treatment received during the ICAP resulted in clinically significant changes in linguistic function (70/100 to 75.4/100). A 5-point increase of the WAB-R AQ score is considered the benchmark for clinical significance (Kertesz, 2017).

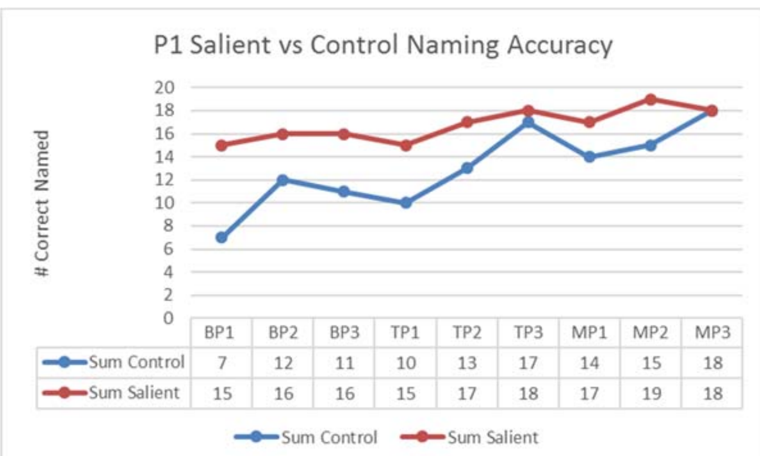


Figure 2. Participant 1's naming accuracy for baseline, therapy, and post-therapy confrontational naming probes. Results are presented as #correct/20 photographic control stimuli and the #correct/20 photographic salient stimuli.

Participant 2. Visual inspection of Figure 3 demonstrates a positive trend in naming accuracy for both the salient and control probes. Participant 2 produced four unstable salient naming targets during the pre-treatment probes, which became 100% stable during the post-treatment probes. Participant 2 had three control targets that were unstable during the pre-testing probe and 67% became stable after treatment.

Participant 2 also demonstrated an increase in impairment-based, linguistic outcome measure scores (i.e., WAB-R and BNT) following the completion of the ICAP (see Table 8). This increase cannot be specifically attributed to the use of salient targets but rather the cumulative effect of all the ICAP therapies including the use of salient targets.

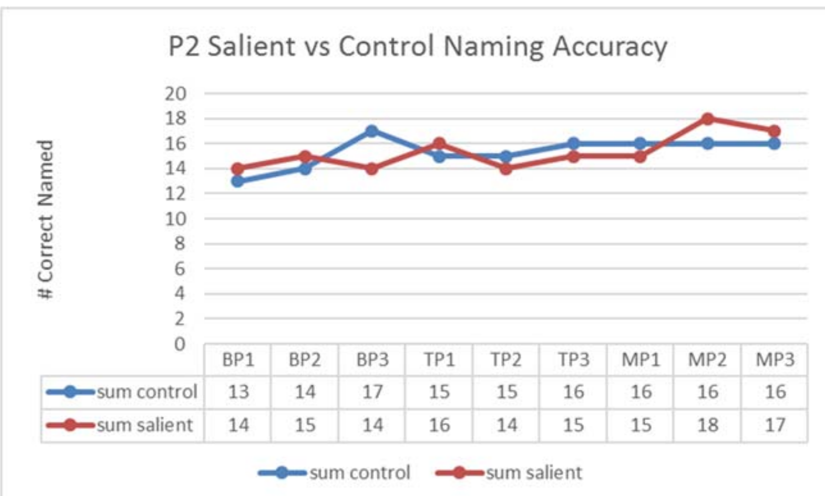


***Figure 3*.** Participant 2's naming accuracy for baseline, therapy and post-therapy confrontational naming probes. Results are presented as #correct /18 photographic control stimuli and the # correct/18 photographic salient stimuli.

Table 8

Post-and post-treatment ICAP Linguistic Outcome Measure Scores

P1	**Pre-ICAP treatment**	**Post –ICAP**
WAB-R Aphasia quotient	70/100	75.4/100*
BNT-2 (standard form)	40/60	43/60
P2		
WAB-R Aphasia quotient	89.4/100	93/100
BNT-2 (standard form)	35/60	39/60

Note. WAB-R= *Western Aphasia Battery Revised*, BNT-2= *Boston Naming Test-2*,
* A five-point gain on the WAB-R is considered clinically significant.

Effect Size Calculations

Effect sizes, as calculated by Busk and Sterlin's (1992) variant of Cohen's (1988) *d,* are reported in Table 9, with 0.2, 0.5 and 0.8 benchmarks for small, medium and large effect sizes (Cohen, 1988). Using these traditional benchmarks, the therapeutic effect sizes for the salient stimuli for both participants were large (d=4.04). The effect sizes for the control stimuli were large for Participant 1 (d = 2.14), and medium for Participant 2 (d = .64). However, Beeson and Robey's (2006) benchmarks for therapeutic effects of word retrieval for single subject, aphasia studies are as follows: d = 2.6 for small effects, d = 3.9 for medium effects and d = 5.8 for large-sized effects. Therefore, by applying Beeson and Robey's benchmarks, participant 1 and 2 demonstrated medium effect sizes (d= 4.04) for their salient probes.

Table 9

Salient vs Control Stimuli Effect Sizes

Participant		BP Mean	BP SD	PTP Mean	Busk & Sterlin's d	Effect size
P1	Salient	15.67	.58	18	4.04	Large
	Control	10	2.65	15.67	2.14	Large
P2	Salient	14.33	.58	16.67	4.04	Large
	Control	14.67	2.08	16	.64	Medium

Note: All probe results for P1 are # correct/25 and for P2 #correct/18; BP = baseline probe; SD = standard deviation; PTP = post treatment probe

Picture Naming Errors

Naming errors from baseline, therapy, and post-therapy confrontational naming probes were analyzed for error type. Naming error analysis revealed that 63.7 % of participant 1's naming errors were semantic naming errors. The most common naming errors produced were coordinate, associate, subordinate, and part to whole semantic errors (see Table 10). For example, when participant 1 was presented with a photograph of an ant, his baseline probe responses included: mosquito and cricket which were both coordinate, semantic errors. Naming error analysis for participant 2 demonstrated that 84.8% of her naming errors were semantic errors (see Table 11). Participant 2's most prevalent errors were: superordinate, circumlocution, subordinate, and associate semantic errors. One of participant 2's most consistent naming errors was to name a photograph of two sausages (salient stimuli) as "Barrons" on the grill. On further investigation, we discovered that participant 2 frequently purchased sausages from Barron's meat market in Montana. "Barrons" on the grill was a subordinate, semantic naming error.

Table 10

Naming Errors for Participant 1

Error Type	BP1	BP2	BP3	TP1	TP2	TP3	PTP1	PTP2	PTP3	Total
Omission					1					**1**
Substitution		1								1
Coordinate	3	3	5	6	2		1	1	1	22
Associate	2	1		3	1		2			9
Superordinate	1	2			1					4
Subordinate	1	2	1	1	2	1				8
Part to Whole			2	2		2		1	1	8
Whole to Part							1			1
Circumlocution	3			1	2					6
Other	8	3	5	2	1	2	5	3	2	31
Total Errors	18	12	13	15	10	5	9	5	4	91

Note: BP=baseline probe, TP=treatment probe, PTP=post-treatment probe

Table 11

Naming Errors for Participant 2

Error Type	BP1	BP2	BP3	TP1	TP2	TP3	PTP1	PTP2	PTP3	Total
Omission										
Substitution				1						1
Coordinate	1					1		1		3
Associated	1	1	1		2				1	6
Superordinate				2	3	4	4	1	1	15
Subordinate	1	1		1	1		1			5
Part to Whole										
Whole to Part										
Circumlocution	4	4	2							10
Other		1	2	1	1				1	6
Total Errors	7	7	5	5	7	5	5	2	3	46

Note: BP=baseline probe, TP=treatment probe, PTP=post-treatment probe

Discussion

This preliminary study was designed to assess the impact of using salient naming targets in aphasia therapy for two individuals with chronic aphasia. The findings demonstrate that incorporating salient targets during aphasia naming therapy increased naming accuracy for both participants. Effect sizes demonstrated a large therapeutic effect for the use of salient naming targets for both participants. These findings are in accordance with previous studies that found increased therapeutic results due to the use of salient targets during aphasia treatment (McKelvey et.al., 2010; Cherney et. al., 2015).

Evidence from this preliminary study suggests that salient targets used during aphasia naming therapies have the potential to increase therapeutic effect sizes. For participant 1, the therapeutic effect sizes were large for both the control and salient targets; with the salient targets demonstrating a larger effect size compared to the control targets (d = 4.04 vs. d = 2.14). Participant 2 demonstrated a larger discrepancy between salient and control targets than participant 1. The therapeutic effect size was large (d = 4.04) using salient naming targets and medium (d = .64) for the control targets. For both participants, salient targets produced large effect sizes.

Results from this study also suggest that using salient naming targets increases word production stability. Stability of production as previously defined, refers to the participants' accurate verbal production of a naming target during two out of three post–treatment probes. Unstable was defined as the verbal production of a naming error during at least two out three pre-treatment probes. Post- treatment, participant 1 demonstrated stable productions of 75% of the pre-treatment unstable salient words and 60% of the unstable pretreatment control words. 100% of participant 2's pre-treatment unstable salient words became stable and 67% of her unstable control words became stable post-treatment.

Error analysis of participant verbal productions during baseline, therapy, and post treatment probes demonstrated a shift in the type of errors produced. Coordinate semantic errors remained participant 1's most common error type before and after intervention; however, participant 1 stopped producing superordinate, subordinate, and circumlocution naming errors during the post treatment probes. Participant 2's pre-treatment naming errors were predominately circumlocution errors but the majority of her post-treatment errors were superordinate errors. Future, additional analysis of this data should include systematic analysis of naming errors in relation to daily naming performance to determine the influence of training on error type. Research using fMRI and cortical mapping have correlated specific speech errors to corresponding brain regions, aphasia types, and aphasia severities across patients (Fridricksson, Baker &Moser, 2009; Corina et.al., 2010). However, recent imaging studies have shown that large-scale reorganization of brain networks occur during aphasia recovery (Baliki, Babbit & Cherney, 2018). Further analysis of data may demonstrate specific changes in naming error types correlate with a decrease in anomia severity.

Theoretical constructs from the field of psychology may lend further support for use of salient naming targets to increase naming accuracy and stability of productions as compared to control targets. The Self Reference Effect (SRE; Rogers et.al., 1977), considered a robust theory in the research of memory (Symons & Johnson, 1997, Cunningham 2008), suggests that stimuli relating to self enhances perception and memory due to increased interactions between brain regions involving attention and memory (Humpreys & Sui, 2016). For example, recalling your own birthdate is easier than recalling other peoples' birthdates due to SRE. Although aphasia is not considered a disability of memory but rather an inability to access intact language, recent research suggests that short-term memory and attention are involved in the naming process (Minkina et. al., 2017). If a naming target is linguistically salient and elicits the SRE, that target may be accessed and verbally produced faster than non-salient targets. Thus, a salient target may become stable before a non-salient target. For example, the word "antique" might be elicited faster, with more accuracy and stability than the word "tractor" for an individual with aphasia that previously owned an antique store.

Motivation associated with salience also likely played a role in the increased accuracy of verbal productions observed in this preliminary study. Each of the participant's salient target choices were selected due to being both personally important and highly motivating. Both incentive salience, which is associated with desirable outcomes, and aversive salience associated with undesirable outcomes are types of motivational salience (Puglis-Allegra & Ventura, 2012; Malenkan, Nestler & Hyman 2009; Koob & Moal, 2008). For example, the word "coffee" is a common salient naming target for individuals with aphasia not only due to the SRE from a history of coffee drinking but also due to the incentive salience of receiving a cup of coffee. This individual will likely produce the salient target "coffee" faster than a less desirable beverage.

Study Limitations and Future Research

This study is a preliminary attempt to explore the impact of using salient targets in aphasia naming therapy. Several methodological considerations limit the generalization of findings. First, only two participants were involved in the study and although it was a single subject design, a multiple participant study could more clearly inform the generalization of the results to others within the population of aphasia. Second, selecting salient words proved more complicated than anticipated. Each participant was asked to choose 20 "salient" words from the list by Palmer et al., (2017) and add five personally salient words that they would like to say. However, for participant 2, choosing 20 targets was difficult as she only chose a total of 18 words from the list and did not add any personal words. Two of participant 1's personal words were not used due to confusion around the use of the words "*Meridian*" and "*Avant*". Furthermore, the participants were able to produce an average of 78% of the salient words and 66% of the control words prior to treatment. All of participant 1's words that were chosen as "highly motivating" as well as two out three of his personal words were being stably produced throughout the study. Starting the study by assisting the participants with the selection of salient and control items not being produced would provide a stronger argument for or against the use of salient targets. However, selecting highly salient targets that are not being produced may pose difficult due to the nature of being salient.

Finally, analysis of functional outcomes comparing therapies that incorporate salient targets versus those that use general targets would provide clinically useful evidence for the incorporation (or not) of salient targets in aphasia therapies. For example, for an individual who participated in a quilting club prior to their stroke, would the incorporation of quilting naming targets lead to their rejoining of the quilting club?

The current research provides support for the use of salient naming targets to increase naming accuracy during aphasia therapy. Because salient targets are person-specific, naming therapies that incorporate salient targets have the potential to incorporate the personal, activity, participation and environmental factors of the WHO-ICF model. Incorporating naming targets that are person-specific and meaningful across multiple environments likely enhance motivation, increase social participation, and improve QOL for individuals with aphasia.

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Appendix A

BIG SKY APHASIA PROGRAM
UNIVERSITY OF MONTANA

Which words would you like to work on in therapy?

- ✓ **Choose 20 personally relevant words from the following list.** Circle the word and mark an "X" for the level of importance for you.
- ✓ For example, you might circle coffee and mark "2" because you enjoy going to coffee with friends.
- ✓ Once you have circled 20 words that are personally relevant, please add 5 of your own at the end of the list.

Word	**Somewhat relevant and motivating**	**Relevant and motivating**	**Highly relevant and motivating**
	1	2	3
Coffee			
Tea			
Water			
Milk			
Banana			
Apple			
Tomatoes			
T.V.			
Chicken			
Potatoes			
Fork			
Steak			

Pants			
Fries			
T-Shirt			
Cookie			
Sandwich			
Doctors			
Dress			
Bread			
Orange			
Soup			
Beef			
Cake			
Football			
Rice			
Burger			
Strawberries			
Shower			
Shoes			
Socks			
Chocolate			
Egg			
Pasta			
Butter			
Bank			
Cheese			
Lettuce			
Pizza			
Ice cream			
Chinese food			
Coat			
Cauliflower			
Fish			
Grapes			
Pepper			
Bathroom			
Washing machine			
Baseball			
Lawnmower			

Mushroom			
Coffee pot			
Broccoli			
Salad			
Breakfast			
Toast			
Sugar			
Hospital			
Dentist			
Slippers			
Soccer			
Orange Juice			
Microwave			
Cereal			
Lasagna			
Pear			
Shovel			
Shirt			
Golf			
Fridge			
Knife			
Baked Potato			
Hockey			
Robin			
Pharmacy			
Post Office			
Airplane			
Beer			
Green beans			
Cucumber			
Sausages			
Shrimp			
Vegetables			
Hose			
Toothpaste			
Car			
Spoon			
Pineapple			

Crow			
Trowel			
Garden			
Jeans			
Sandals			
Wine			
Plate			
Kitchen			
Watch			
Supermarket/Grocery Store			
Basketball			
Cherry			

Please add 5 of your own personally relevant words:

1. ____

2. ____

3. ____

4. ____

5. ____

Word list from: Palmer, R., Hughes, H., Chater, T., (2017). What do people with aphasia want to be able to say? A content analysis of words identified as personally relevant by people with aphasia. *PLOS one*, https://doi.org/10.1371/journal.pone.0174065